

# Лабораторная работа №13

Операционные системы

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- Приобрести простейшие навыки разработки, анализа, тестирования и отладки приложений в ОС типа UNIX/Linux на примере создания на языке программирования С калькулятора с простейшими функциями.

## Выполнение лабораторной работы

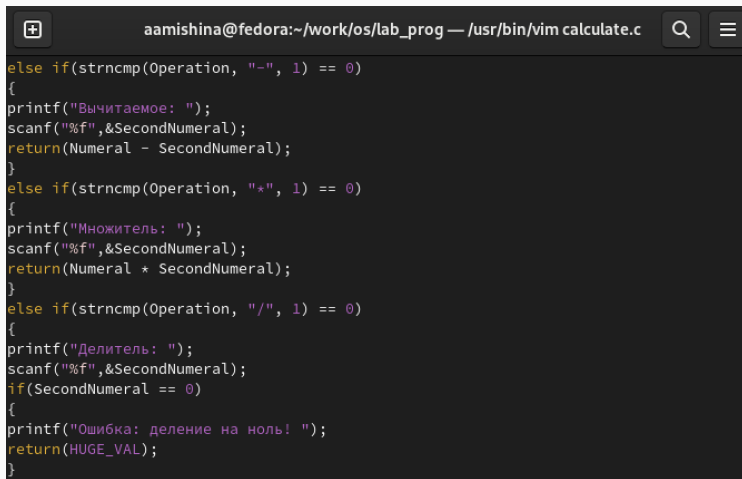
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```
[aamishina@fedora ~]$ cd ~/work/os  
[aamishina@fedora os]$ mkdir lab_prog  
[aamishina@fedora os]$ cd lab_prog/  
[aamishina@fedora lab_prog]$ pwd  
/home/aamishina/work/os/lab_prog
```

Рис. 1: Создание поддиректории ~/work/os/lab\_prog.

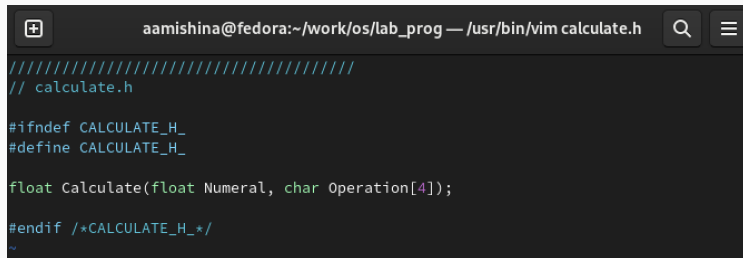
```
[aamishina@fedora lab_prog]$ touch calculate.c calculate.h main.c  
[aamishina@fedora lab_prog]$ ls  
calculate.c calculate.h main.c
```

Рис. 2: Создание и заполнение файлов.



```
else if(strncmp(Operation, "-", 1) == 0)
{
printf("Вычитаемое: ");
scanf("%f",&SecondNumeral);
return(Numeral - SecondNumeral);
}
else if(strncmp(Operation, "*", 1) == 0)
{
printf("Множитель: ");
scanf("%f",&SecondNumeral);
return(Numeral * SecondNumeral);
}
else if(strncmp(Operation, "/", 1) == 0)
{
printf("Делитель: ");
scanf("%f",&SecondNumeral);
if(SecondNumeral == 0)
{
printf("Ошибка: деление на ноль! ");
return(HUGE_VAL);
}
```

Рис. 3: Содержимое файла calculate.c.

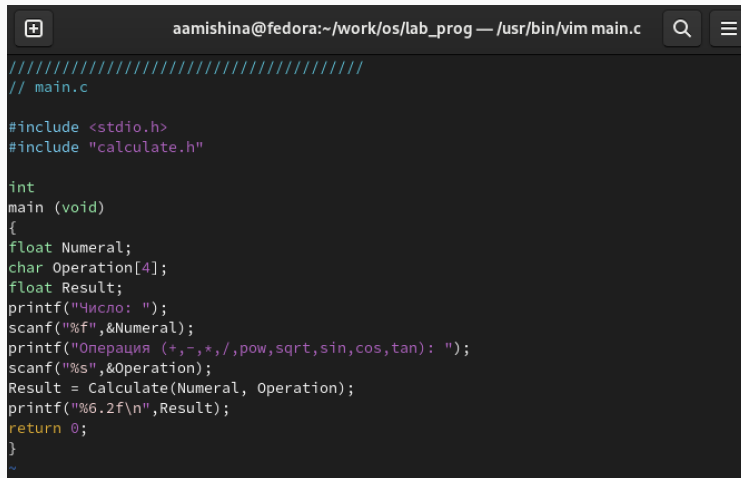


The image shows a terminal window with the Vim editor open. The title bar indicates the user is 'aamishina' on a 'fedora' system, in the directory '~/work/os/lab\_prog', editing the file 'calculate.h'. The editor's status bar shows search and menu icons. The file content is as follows:

```
////////////////////////////////////  
// calculate.h  
  
#ifndef CALCULATE_H_  
#define CALCULATE_H_  
  
float Calculate(float Numeral, char Operation[4]);  
  
#endif /*CALCULATE_H_*/  
~
```

Рис. 4: Содержимое файла calculate.h.





```
#####  
// main.c  
  
#include <stdio.h>  
#include "calculate.h"  
  
int  
main (void)  
{  
    float Numeral;  
    char Operation[4];  
    float Result;  
    printf("Число: ");  
    scanf("%f",&Numeral);  
    printf("Операция (+,-,*,/,pow,sqrt,sin,cos,tan): ");  
    scanf("%s",&Operation);  
    Result = Calculate(Numeral, Operation);  
    printf("%.2f\n",Result);  
    return 0;  
}  
~
```

Рис. 5: Содержимое файла main.c.

```
[aamishina@fedora lab_prog]$ gcc -c calculate.c  
[aamishina@fedora lab_prog]$ gcc -c -g main.c  
[aamishina@fedora lab_prog]$ gcc calculate.o main.o -o calcul -lm  
[aamishina@fedora lab_prog]$
```

Рис. 6: Компиляция программы.

- В Makefile указываю компилятор gcc, флаг -g и дополнительные библиотеки -lm. Описываю, какие команды необходимо запустить, чтобы получить файлы calcul, calculate.o и main.o, подключив дополнительные библиотеки и флаги. А в поле clean описывается удаление файлов calcul и файлов, оканчивающихся на ".o".

```
#  
# Makefile  
#  
  
CC=gcc  
CFLAGS=-g  
LIBS=-lm  
  
calcul: calculate.o main.o  
gcc calculate.o main.o -o calcul $(LIBS)  
  
calculate.o: calculate.c calculate.h  
gcc -c calculate.c $(CFLAGS)  
  
main.o: main.c calculate.h  
gcc -c main.c $(CFLAGS)  
  
clean:  
-rm calcul *.o  
  
# End Makefile  
~
```

## Запуск отладчика GDB

```
[aamishina@fedora lab_prog]$ gdb ./calcul
GNU gdb (GDB) Fedora Linux 12.1-7.fc37
Copyright (C) 2022 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "aarch64-redhat-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
  <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from ./calcul...

This GDB supports auto-downloading debuginfo from the following URLs:
https://debuginfod.fedoraproject.org/
Enable debuginfod for this session? (y or [n]) y
Debuginfod has been enabled.
To make this setting permanent, add 'set debuginfod enabled on' to .gdbinit.
(No debugging symbols found in ./calcul)
(gdb) run
Starting program: /home/aamishina/work/os/lab_prog/calcul
Downloading 0.03 MB separate debug info for system-supplied DSO at 0xffffffff7fb000
Downloading 1.63 MB separate debug info for /lib64/libm.so.6
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib64/libthread_db.so.1".
Число: 5
Операция (*,-,*,/,pow,sqrt,sin,cos,tan): pow
Степень: 2
25.00
[Inferior 1 (process 4678) exited normally]
```

Рис. 8: Запуск отладчика и программы внутри отладчика.

```
(gdb) list
1      //////////////////////////////////////////
2      // main.c
3
4      #include <stdio.h>
5      #include "calculate.h"
6
7      int
8      main (void)
9      {
10     float Numeral;
(gdb) list 12,15
12     float Result;
13     printf("Число: ");
14     scanf("%f",&Numeral);
15     printf("Операция (+,-,*,/,pow,sqrt,sin,cos,tan): ");
(gdb) █
```

Рис. 9: Просмотр исходного кода постранично и указанных строк.

```
(gdb) break 17
Breakpoint 1 at 0x400bd0: file main.c, line 17.
(gdb) info breakpoints
Num   Type             Disp Enb Address            What
1     breakpoint       keep y   0x0000000000400bd0 in main at main.c:17
(gdb) run
Starting program: /home/aamishina/work/os/lab_prog/calcul

This GDB supports auto-downloading debuginfo from the following URLs:
https://debuginfod.fedoraproject.org/
Enable debuginfod for this session? (y or [n]) y
Debuginfod has been enabled.
To make this setting permanent, add 'set debuginfod enabled on' to .gdbinit.
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib64/libthread_db.so.1".
Число: 5
Операция (+,-,*,/,pow,sqrt,sin,cos,tan): -

Breakpoint 1, main () at main.c:17
17      Result = Calculate (Numeral, Operation);
(gdb) backtrace
#0  main () at main.c:17
(gdb) print Numeral
$1 = 5
(gdb) display Numeral
1: Numeral = 5
(gdb) info breakpoints
Num   Type             Disp Enb Address            What
1     breakpoint       keep y   0x0000000000400bd0 in main at main.c:17
      breakpoint already hit 1 time
(gdb) delete 1
(gdb) info breakpoints
No breakpoints or watchpoints.
(gdb)
```

Рис. 10: Точка останова, просмотр информации и значения переменной

```
[aanishina@fedora lab_prog]$ splint calculate.c
Splint 3.1.2 --- 23 Jul 2022

calculate.h:7:37: Function parameter Operation declared as manifest array (size
constant is meaningless)
A formal parameter is declared as an array with size. The size of the array
is ignored in this context, since the array formal parameter is treated as a
pointer. (Use -fixedformalarray to inhibit warning)
calculate.c:10:31: Function parameter Operation declared as manifest array
(size constant is meaningless)
calculate.c: (in function Calculate)
calculate.c:16:1: Return value (type int) ignored: scanf("%f", &Sec...
Result returned by function call is not used. If this is intended, can cast
result to (void) to eliminate message. (Use -retvalint to inhibit warning)
calculate.c:22:1: Return value (type int) ignored: scanf("%f", &Sec...
calculate.c:28:1: Return value (type int) ignored: scanf("%f", &Sec...
calculate.c:34:1: Return value (type int) ignored: scanf("%f", &Sec...
calculate.c:35:4: Dangerous equality comparison involving float types:
SecondNumeral == 0
Two real (float, double, or long double) values are compared directly using
== or != primitive. This may produce unexpected results since floating point
representations are inexact. Instead, compare the difference to FLT_EPSILON
or DBL_EPSILON. (Use -realcompare to inhibit warning)
calculate.c:38:7: Return value type double does not match declared type float:
(HUGE_VAL)
To allow all numeric types to match, use -relaxtypes.
calculate.c:46:1: Return value (type int) ignored: scanf("%f", &Sec...
calculate.c:47:7: Return value type double does not match declared type float:
(pow(Numeral, SecondNumeral))
calculate.c:50:7: Return value type double does not match declared type float:
(sqrt(Numeral))
calculate.c:52:7: Return value type double does not match declared type float:
(sin(Numeral))
calculate.c:54:7: Return value type double does not match declared type float:
(cos(Numeral))
calculate.c:56:7: Return value type double does not match declared type float:
(tan(Numeral))
calculate.c:60:7: Return value type double does not match declared type float:
(HUGE_VAL)

Finished checking --- 15 code warnings
[aanishina@fedora lab_prog]$
```

Рис. 11: Выполнение команды splint calculate.c.



```
[aamishina@fedora lab_prog]$ splint main.c
Splint 3.1.2 --- 23 Jul 2022

calculate.h:7:37: Function parameter Operation declared as manifest array (size
                    constant is meaningless)
    A formal parameter is declared as an array with size. The size of the array
    is ignored in this context, since the array formal parameter is treated as a
    pointer. (Use -fixedformalarray to inhibit warning)
main.c: (in function main)
main.c:14:1: Return value (type int) ignored: scanf("%f", &Num...
    Result returned by function call is not used. If this is intended, can cast
    result to (void) to eliminate message. (Use -retvalint to inhibit warning)
main.c:16:12: Format argument 1 to scanf (%s) expects char * gets char [4] *:
                    &Operation
    Type of parameter is not consistent with corresponding code in format string.
    (Use -formattype to inhibit warning)
    main.c:16:9: Corresponding format code
main.c:16:1: Return value (type int) ignored: scanf("%s", &Ope...

Finished checking --- 4 code warnings
[aamishina@fedora lab_prog]$
```

Рис. 12: Выполнение команды splint main.c.

- В ходе выполнения лабораторной работы я приобрела простейшие навыки разработки, анализа, тестирования и отладки приложений в ОС типа UNIX/Linux на примере создания на языке программирования С калькулятора с простейшими функциями.